Rotary atomizing electrostatic coating apparatus

Patent number: EP0801991
Publication date: 1997-10-22
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Classification:
- international: B05B5/04
- european: B05B5/053B; B05B5/04B
Application number: EP19970106001 19970411
Priority number(s): JP19960093792 19960416

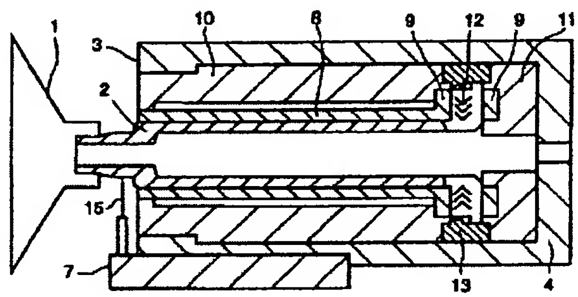
Also published as:
JP9276750 (A)
EP0801991 (A3)

Cited documents:
US4589597
US4887770
US4398672
US3536514

Abstract of **EP0801991**

A rotary atomizing electrostatic coating apparatus includes a pin type electrode (15) provided so as to oppose any one of the atomizing head (1) and the drive shaft (2). The atomizing head (1) is electrically charged by using a corona discharge generated between the pin type electrode (15) and the atomizing head (1) or the drive shaft (2). Due to this structure, the bearing (8,9) for rotatably supporting the drive shaft (2) and the bearing housing (10,11) can be made from ceramics or synthetic resin. As a result, the coating apparatus is compact in size and is lightened.

FIG. 1



(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 801 991 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
19.08.1998 Bulletin 1998/34

(51) Int. Cl.^{6}: B05B 5/04

(43) Date of publication A2:
22.10.1997 Bulletin 1997/43

(21) Application number: 97106001.7

(22) Date of filing: 11.04.1997

(84) Designated Contracting States:
DE FR GB

(30) Priority: 16.04.1996 JP 93792/96

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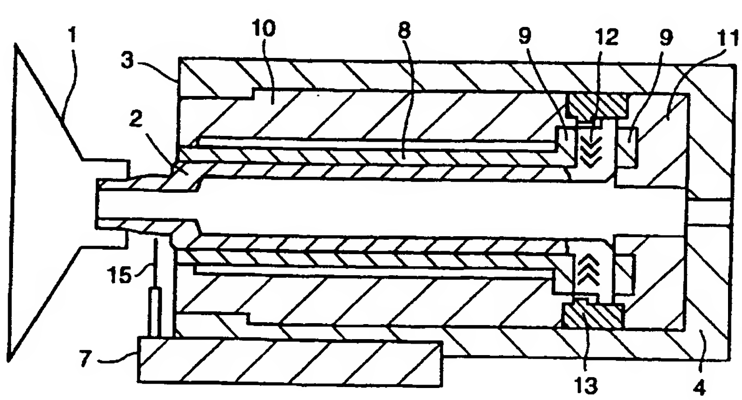

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EUROPEAN SEARCH REPORT

Application Number
EP 97 10 6001

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 589 597 A (ROBISCH HERMAN ET AL) 20 May 1986 * column 2, line 22 - column 3, line 16 * * column 3, line 36 - line 60; figures *	1,3-10	B05B5/04
X	US 4 887 770 A (WACKER ROBERT L ET AL) 19 December 1989 * column 5, line 65 - column 6, line 9 * * column 7, line 31 - column 8, line 2 * * column 10, line 20 - column 11, line 3; figure 2 *	1,3,7	
A	US 4 398 672 A (ARNOLD ARTHUR J ET AL) 16 August 1983 * column 3, line 41 - line 54; figures *	1,3	
A	US 3 536 514 A (LAFAVE RICHARD L ET AL) 27 October 1970 * figure 4B *	2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 1998	Brévier, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

(19) Europäisches Patentamt
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(11) EP 0 801 991 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.10.1997 Bulletin 1997/43

(51) Int. Cl.[6]: B05B 5/04

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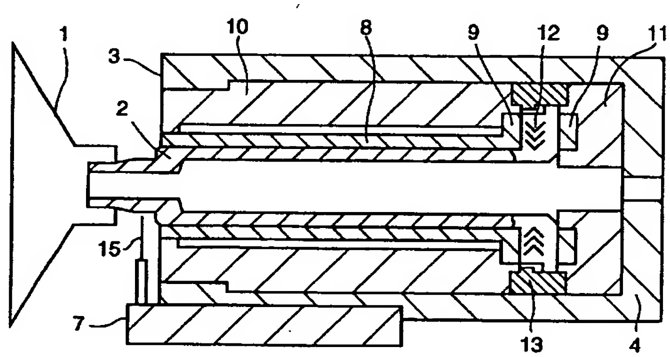
(57) A rotary atomizing electrostatic coating apparatus includes a pin type electrode (15) provided so as to oppose any one of the atomizing head (1) and the drive shaft (2). The atomizing head (1) is electrically charged by using a corona discharge generated between the pin type electrode (15) and the atomizing head (1) or the drive shaft (2). Due to this structure, the bearing (8,9) for rotatably supporting the drive shaft (2) and the bearing housing (10,11) can be made from ceramics or synthetic resin. As a result, the coating apparatus is compact in size and is lightened.

FIG. 1



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Description

The present invention relates to a rotary atomizing electrostatic coating apparatus, and more particularly to a rotary atomizing electrostatic coating apparatus capable of lightening an air motor.

A typical currently used rotary atomizing electrostatic coating apparatus is illustrated in FIGS. 3 and 4. The rotary atomizing electrostatic coating apparatus generally includes an atomizing head (bell head) 1, a drive shaft 2, an air motor 3', a main housing 4', a shaping air cap 5, at least one paint feed tube 6, and a high voltage generator 7. The air motor 3' includes a radial bearing 8', a thrust bearing 9', bearing housings 10' and 11' for supporting the radial bearing 8' and the thrust bearing 9', respectively, and an air supply nozzle 13' for driving a turbine. For the bearing of the air motor 3', a static-pressure air bearing is currently used. In the static-pressure air bearing, compressed air from an external air source is supplied to a radial gap between the air bearing 8' and the drive shaft 2, so that the drive shaft 2 floats from the air bearing 8' to produce a non-contact and completely oil less condition. The atomizing head 1 coupled to the drive shaft 2 is driven by supplying compressed air to turbine blades 12 fixed to the drive shaft.

To electrically charge the atomizing head 1 to a high voltage, all elements of the air motor except the bearing metal are made from electrically conductive material (usually metal, and more particularly the housings 10' and 11' are made from aluminum and the bearings 8' and 9' are made from zinc bronze), and electrical charge is generated by contacting an electrode pin 14 to an outside surface of the air motor 1. In this instance, a clearance between the bearings 8' and 9' and the drive shaft 2 is small and the bearings 8' and 9' are charged to a high voltage, so that an electric discharge is generated between the bearings 8' and 9' and the drive shaft 2 to electrically charge the drive shaft 2 (made from stainless steel) and the atomizing head 1. The electrode pin 14 (which may be replaced by a coil spring or a plate spring) is not permitted to contact the drive shaft 2. This is because if the electrode pin 14 contacts the drive shaft 2, a load will act on the drive shaft 2 to deteriorate the floating support of the drive shaft 2.

However, the conventional apparatus has the following problems because the elements of the air motor are made from the electrically conductive material (usually, metal):

First, since the metal material has a large specific gravity, the air motor is heavy.

Second, the electrically conductive air motor should be covered with an electric insulator having a sufficient thickness. The insulator corresponds to the main housing 4' in FIG. 4 which is made from, for example, polyethylene terephthalate). As a result, weight and size of the apparatus increases.

An object of the present invention is to provide a rotary atomizing electrostatic coating apparatus capable of lightening an air motor, thus the apparatus itself.

A rotary atomizing electrostatic coating apparatus according to the present invention includes a drive shaft to which an atomizing head is coupled and an air motor for supporting and driving the drive shaft. In the apparatus, a pin electrode (needle electrode) is provided so as to oppose the drive shaft or the atomizing head so that a corona charge is generated between the electrode and the drive shaft or the atomizing head to electrically charge the atomizing head directly or via the drive shaft.

In the above-described apparatus, since the drive shaft or the atomizing head is electrically charged without contacting the electrode to the drive shaft or the atomizing head and using the corona discharge, the bearing and the bearing housing of the air motor are permitted to be made from electrically non-conductive material, for example, ceramics and synthetic resin, so that the air motor and the apparatus are lightened as compared with the conventional air motor made from metal and the conventional apparatus.

The above and other objects, features, and advantages of the present invention will become more apparent and will be more readily appreciated from the following detailed description of the preferred embodiments of the present invention in conjunction with the accompanying drawings, in which:

FIG.1 is a schematic cross-sectional view of a rotary atomizing electrostatic coating apparatus according to a first embodiment of the present invention;

FIG.2 is a schematic cross-sectional view of a rotary atomizing electrostatic coating apparatus according to a second embodiment of the present invention;

FIG.3 is a cross-sectional view of a conventional rotary atomizing electrostatic coating apparatus; and

FIG.4 is a schematic cross-sectional view of the conventional rotary atomizing electrostatic apparatus.

FIG. 1 illustrates a rotary atomizing electrostatic coating apparatus according to a first embodiment of the present invention, and FIG. 2 illustrates a rotary atomizing electrostatic coating apparatus according to a second embodiment of the present invention. Portions common or similar to the first and second embodiments of the present invention are denoted with the same reference numerals throughout the first and second embodiments of the present invention.

First, portions common or similar to the first and second embodiments of the present invention will be explained with reference to, for example, FIG. 1.

A rotary atomizing electrostatic coating apparatus according to any one of the first and second embodiments of the present invention generally includes a

rotatable atomizing head (bell head) 1 for atomizing and scattering paint, a rotatable hollow drive shaft having a front end to which the atomizing head 1 is coupled, an air motor 3 for rotatably and floatingly supporting and rotating the drive shaft 2, a main housing 4 housing the air motor 3 therein, a shaping air cap 5 coupled to a front end of the main housing 4 (similar to the structure of FIG. 3), at least one paint feed tube 6 (similar to the structure of FIG. 3), and a high voltage generator 7 for charging electricity finally to the atomizing head 1 to a high voltage. The high voltage generator 7 contacts neither the atomizing head 1 nor members electrically connected to the atomizing head.

The air motor 3 includes a radial bearing 8 rotatably supporting the drive shaft 2, a thrust bearing 9, housings 10 and 11 for supporting the bearings 8 and 9, respectively, an air supply nozzle 13 for supplying air to turbine blades 12 integrally coupled to the drive shaft 2. For the bearings 8 and 9 of the air motor 3, a static-pressure air bearing is used. The static-pressure air bearing causes the drive shaft 2 to float from the bearings 8 and 9 by supplying air from an external air source to a clearance (several to one hundred microns in thickness) between the drive shaft 2 and the bearings 8 and 9, whereby non-contact and completely oil-less rotation of the drive shaft is conducted. The atomizing head 1 coupled to the drive shaft 2 is rotated by supplying compressed air to the turbine blades 12 of the drive shaft 2.

With respect to a structure for charging the atomizing head to a high voltage, an electrode 15 having a configuration of a pin or needle (hereinafter, a pin type electrode or a needle type electrode) is provided so as to oppose the drive shaft 2 or the atomizing head 1 with a gap remaining therebetween. Electricity is charged to the drive shaft 2 or the atomizing head 1 utilizing a corona discharge (a discharge emitting a weak light from a tip of the electrode, which is generated before spark discharge occurs) generated between the pin type electrode 15 and the drive shaft 2 or the atomizing head 1 when the electrode 15 is charged at a high voltage (for example, several thousand volts). By this corona discharge, the atomizing head 1 is charged directly or via the drive shaft 2. The atomizing head 1 and the drive shaft 2 are made from electrically conductive material (for example, stainless steel). The pin type electrode 15 is electrically connected to the high voltage generator 7.

Due to the above-described structure, the bearings 8 and 9 and the bearing housings 10 and 11 do not need to be made from electrically conductive material, and can be made from electrically non-conductive material such as synthetic resin and ceramics. In the present invention, the radial bearing 8 and the thrust bearing 9 are made from ceramics, and the bearing housings 10 and 11 are made from synthetic resin (more particularly, polyethylene terephthalate).

As a result, since ceramics and synthetic resin have specific gravities smaller than metal materials, the air motor 3 and the coating apparatus including the air motor are lightened compared with the conventional air motor made from metal materials and the apparatus including the conventional air motor.

Further, since synthetic resin (for example, polyethylene terephthalate) is a hardness lower than that of metal material, a time period needed for machining the synthetic resin parts is decreased, whereby the manufacturing cost is also decreased.

Furthermore, by decreasing a number of the parts made from electrically conductive material, an electrostatic capacity of the apparatus is also small so that handling the apparatus is easy.

Next, portions unique to each embodiment of the present invention will be explained.

With a first embodiment of the present invention, as illustrated in FIG. 1, the air motor 3 and the main housing 4 are separate members to each other. The main housing 4 is made from synthetic resin (more particularly, polyethylene terephthalate). The high voltage generator 7 and an shaping air passage 16 (see FIG. 3) are disposed or formed in the housing 4.

Since the bearing housings 10 and 11 which constitute an outer portion of the air motor 3 are made from electrically non-conductive synthetic resin, the main housing 4 does not need to be thick from the viewpoint of electric insulation. As a result, the apparatus can be compact in size and can be lightened.

With a second embodiment of the present invention, the outer synthetic resin housings 10 and 11 of the air motor 3 function also as a main housing so that a particular main housing 4 does not need to be provided. Within the housings 10 and 11 of the air motor 3, the high voltage generator 7 and the shaping air passage 16 (see FIG. 3) are disposed or formed.

Since the bearing housings 10 and 11 function also as the main housing 4 and a particular main housing separate from the bearing housings does not need to be provided, the apparatus can be down-sized and lightened to a great extent.

According to any one of the first and second embodiments of the present invention, since the atomizing head is electrically charged using corona discharge by providing a pin type or needle type electrode opposing the atomizing head or the drive shaft, the bearings and bearing housings of the air motor do not need to be made from metal, so that the air motor and the coating apparatus can be lightened and be compact in size.

Claims

1. A rotary atomizing electrostatic coating apparatus comprising:

   a main housing (4);
   a drive shaft (2) housed in said main housing (4):
   an air motor (3) including an air bearing for floatingly and rotatably supporting said drive shaft (2), a turbine for driving said drive shaft

(2), and a bearing housing (10,11) for supporting said air bearing (8,9);
an atomizing head (1) coupled to said drive shaft (2) so as to rotate together with said drive shaft (2);
a high voltage generator (7) for generating a high voltage of electricity; and
a pin type electrode (15) electrically connected to said high voltage generator (7) and disposed so as to oppose any one of said drive shaft (2) and said atomizing head (1).

2. An apparatus according to claim 1, wherein said pin type electrode (15) opposes said drive shaft (2).

3. An apparatus according to claim 1, wherein said pin type electrode (15) opposes said atomizing head (1).

4. An apparatus according to claim 1, wherein said air bearing (8,9) is made from electrically non-conductive material.

5. An apparatus according to claim 4, wherein said electrically non-conductive material is a ceramic.

6. An apparatus according to claim 4, wherein said electrically non-conductive material is a synthetic resin.

7. An apparatus according to claim 1, wherein said bearing housing (10,11) is made from electrically non-conductive material.

8. An apparatus according to claim 7, wherein said electrically non-conductive material is a ceramic.

9. An apparatus according to claim 7, wherein said electrically non-conductive material is a synthetic resin.

10. An apparatus according to claim 1, wherein said main housing (4) is constructed from the bearing housing (10,11) of the air motor (3).

FIG. 1

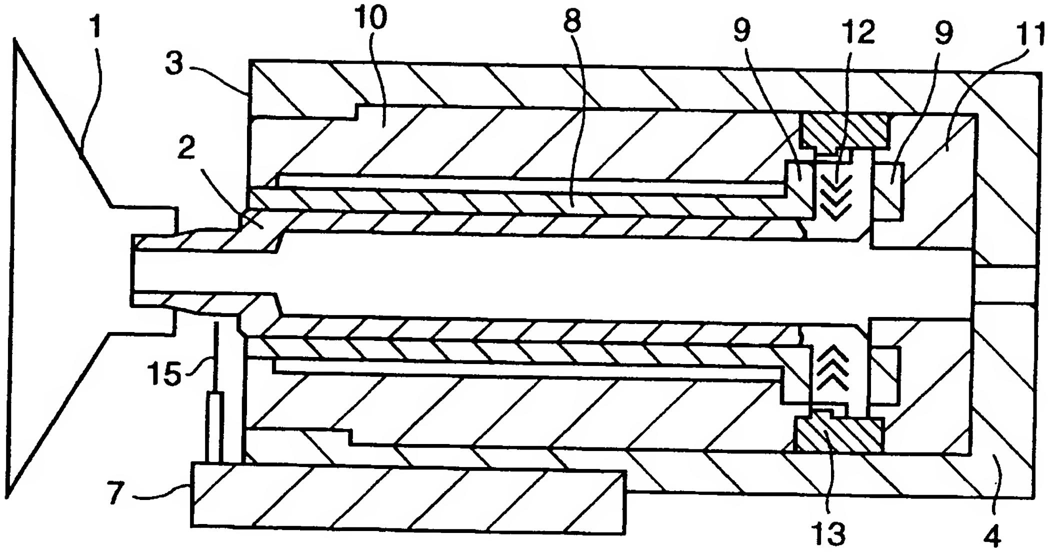


FIG. 2

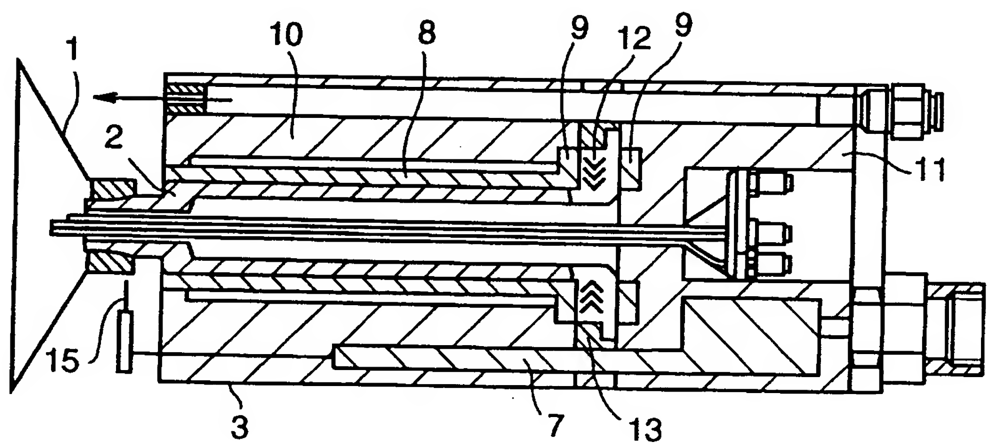


FIG. 3 (PRIOR ART)

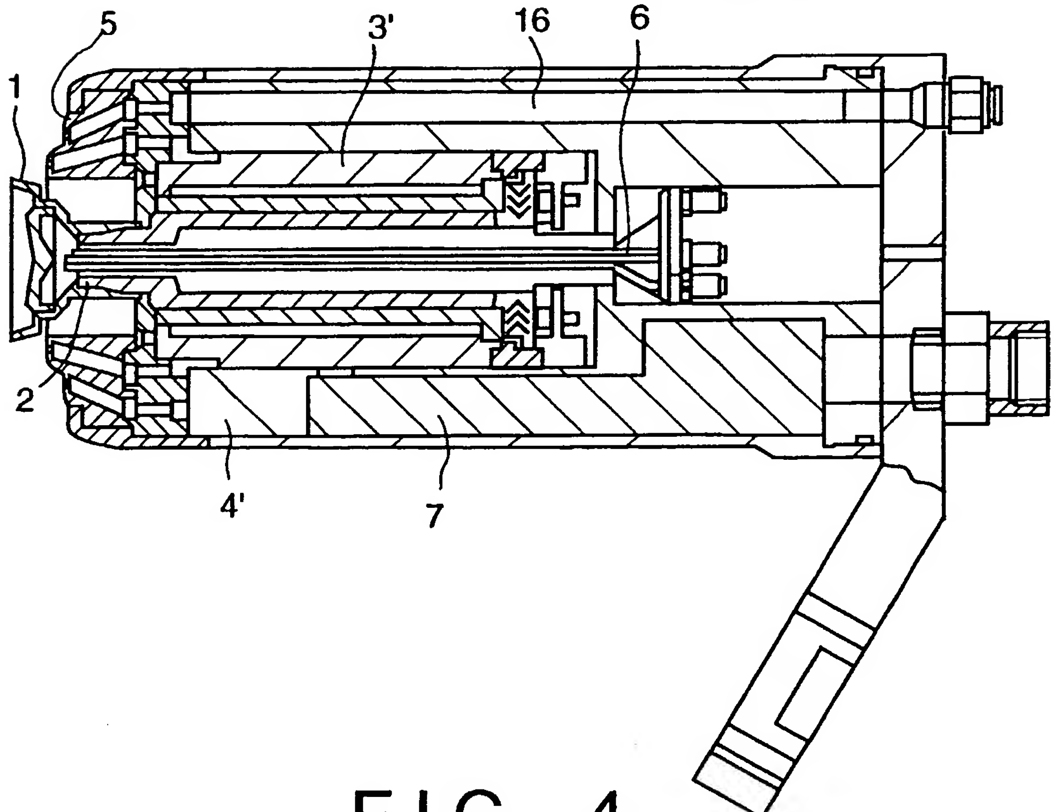
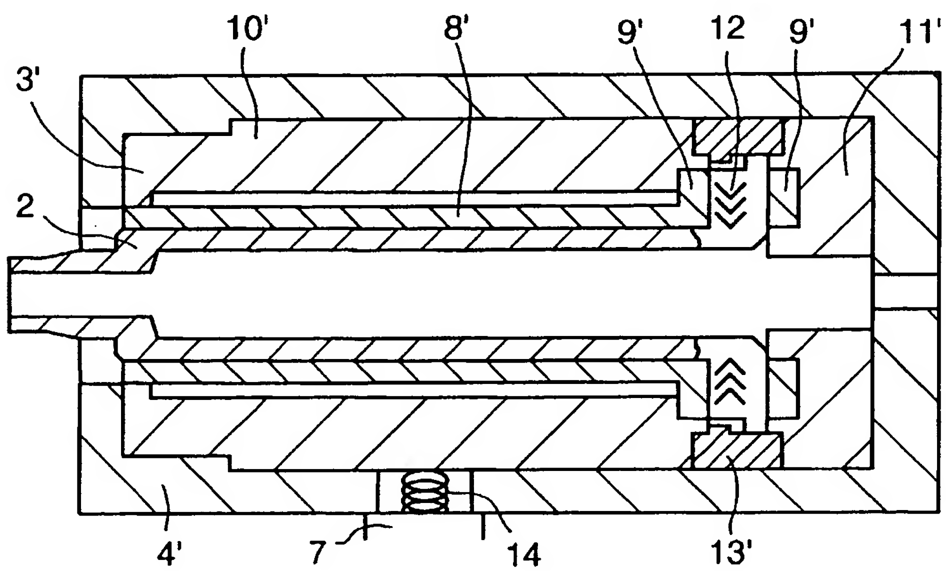


FIG. 4 (PRIOR ART)



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(11) EP 0 801 991 A3

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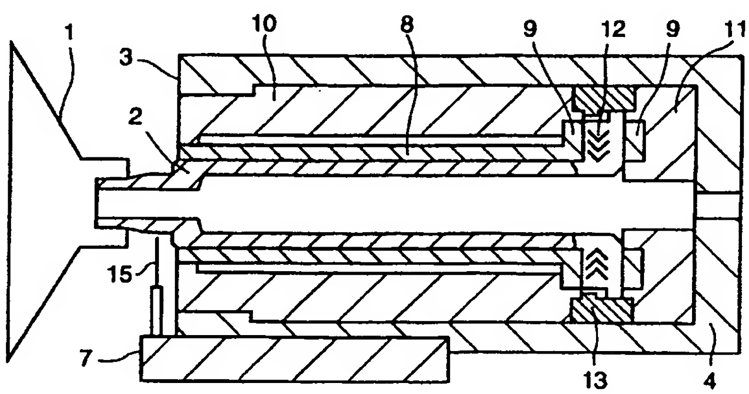

EP 0 801 991 A3

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EUROPEAN SEARCH REPORT

Application Number
EP 97 10 6001

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 4 589 597 A (ROBISCH HERMAN ET AL) 20 May 1986 * column 2, line 22 - column 3, line 16 * * column 3, line 36 - line 60; figures * ---	1,3-10	B05B5/04
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A	US 3 536 514 A (LAFAVE RICHARD L ET AL) 27 October 1970 * figure 4B * -----	2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 1998	Brévier, F

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